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## PROXIMITY RESPONSIVE SYSTEM

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Filed Feb. 24, 1964, Ser. No. 346,956

9 Claims. (Cl. 317-146)

The present invention relates to a proximity sensitive system, and particularly to a system sensitive to the proximity of an extraneous object for operating an external device.

There are various applications for such proximity sensitive systems. The one particularly described herein is a system for automatically turning on the water tap when the user's hands are positioned close to the tap, or other specified location, and for automatically turning off the tap when the user's hands are removed. It has been found that, in some cases, as much as 25-30% of water can be saved by utilizing such a system. Among previously known systems of this type is one based on an optical system utilizing a photocell and a light beam which is broken by the presence of the user's hands, and another based on an electronic system utilizing the change in frequency upon the proximity of an extraneous object. In practice, however, these systems were usually not sufficiently reliable, sensitive and stable in operation to gain widespread use.

While the invention is hereinafter described with respect to an application involving automatically turning on and off the water from a water tap, it will be understood that this is but one application of the system, and that it could be used equally well in other types of applications.

Among the objects of the present invention are to provide a proximity sensitive system which is reliable and sensitive in operation, which has stable operating characteristics even with temperature fluctuations, and which is simple in construction and relatively inexpensive to produce and to maintain.

According to the invention, there is provided a system sensitive to the proximity of an extraneous object for operating an external device comprising an electrical circuit including an oscillator and a tank circuit for controlling the frequency of the oscillator, sensing means, or a probe, for sensing the proximity of the extraneous object, and control means responsive to the sensed proximity of the extraneous object and operative to control an external device. The invention is characterized, in its broadest aspect, by the provision of a shunt across the tank circuit, the shunt including a resistor and the probe. In this arrangement, the probe is very sensitive to the proximity of the extraneous object and changes the Q of the tank circuit to produce a change in amplitude in the output of the oscillator, the control means being responsive to the change in output amplitude to operate the external device.

The Q of a tank circuit, as is known, is a comparison of the total power in the circuit to the power dissipated. It is usually expressed as the ratio of the inductive reactance at resonance to the resistance. When the Q increases, the output amplitude of the circuit is increased, and vice versa.

According to another feature of the invention, the oscillator includes a transistor, and the tank circuit is connected between the emitter and base of the transistor. One side of the resistor in the above-mentioned shunt is connected to the juncture between one side of the tank circuit and the input circuit to the transistor base, and the other side of the resistor is connected to the probe.

By including the probe in a resistance shunt with respect

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to the tank circuit, the probe is very sensitive for larger distances. It has been found that if this resistor is omitted, this not only decreases the distance over which the probe is sensitive, but also tends to increase the amount of external radiation produced by the system which can disturb other equipment.

Other aspects and features of the invention will become apparent from the following description.

The accompanying drawings illustrate, diagrammatically and by way of example only, two preferred embodiments of the invention. In the drawings:

FIG. 1 is a block diagram of a proximity sensitive system constructed in accordance with the invention;

FIG. 2 is a circuit diagram of a system, such as the one in FIG. 1, for use in controlling a water tap in response to the proximity of the user's hand.

FIG. 3 is a circuit diagram of another system constructed in accordance with the invention; and

FIG. 4 illustrates an electrical circuit, such as that of FIG. 3, in miniaturized form wherein its circuit elements are enclosed within three spaced, sealed housings to protect against temperature fluctuations.

With reference to FIG. 1, the novel system comprises a resonant tank circuit 10, including an inductance L1 and a capacitor C1, the tank circuit controlling the frequency of an oscillator 20. The output of oscillator 20 is coupled to an electronic switch or amplifier 30 which controls a solenoid 40 so that current flows through the solenoid when switch 30 is actuated.

In shunt with the tank circuit 10 is a resistor R1 and the sensing element S which senses the proximity of the extraneous object to actuate the electronic switch 30 to pulse solenoid 40.

The sensing means S is in the form of a capacitive probe having a pair of electrodes spaced from each other and therefore having a capacitance therebetween. The two electrodes are generally indicated by the reference numerals 2 and 4, respectively. When the extraneous object whose proximity is being sensed approaches the two electrodes 2 and 4, the capacitance between these electrodes increases, and therefore the capacitive reactance of the shunt circuit increases. This decreases the impedance of the shunt. A shunt of decreased impedance across the tank circuit 10 decreases the output amplitude and the Q of the circuit. This causes the output amplitude of oscillator 20 to be decreased, this decrease in output being sensed by electronic switch 30 to actuate solenoid 40.

For purposes of increasing the sensitivity of the system, electrodes 2 and 4 of the sensing element S are provided with enlarged surface areas 6 and 8, respectively.

The circuit of FIG. 2 illustrates a practical circuit and application of this system. In FIG. 2, the system is used for operating a valve 50 for turning on and off a water tap 55 in response to placing the user's hand in a specified location or area as sensed by sensing element S.

The oscillator used in the system of FIG. 2 is a Hartley oscillator commonly used for the production of R-F signals. The frequency of the oscillations is determined by the L-C constant of the resonant tank circuit including inductance L1 and capacitance C1. The oscillator includes a PNP transistor T1, the collector of which is connected to minus terminal B-. Its emitter is connected to a resistor R3, then to a tap on inductance L1, and then to plus terminal B+ through a resistor R5. Bias for transistor T1 is provided by base current through resistor R2 and capacitor C2. In shunt with the tank circuit L1, C1 is the sensing element S for sensing the proximity of the user's hand, this sensing element including, as in FIG. 1, two spaced electrodes 2 and 4 having enlarged surface areas 6 and 8, respectively. One of the electrodes 4 is connected to ground, and the other electrode 2 is con-